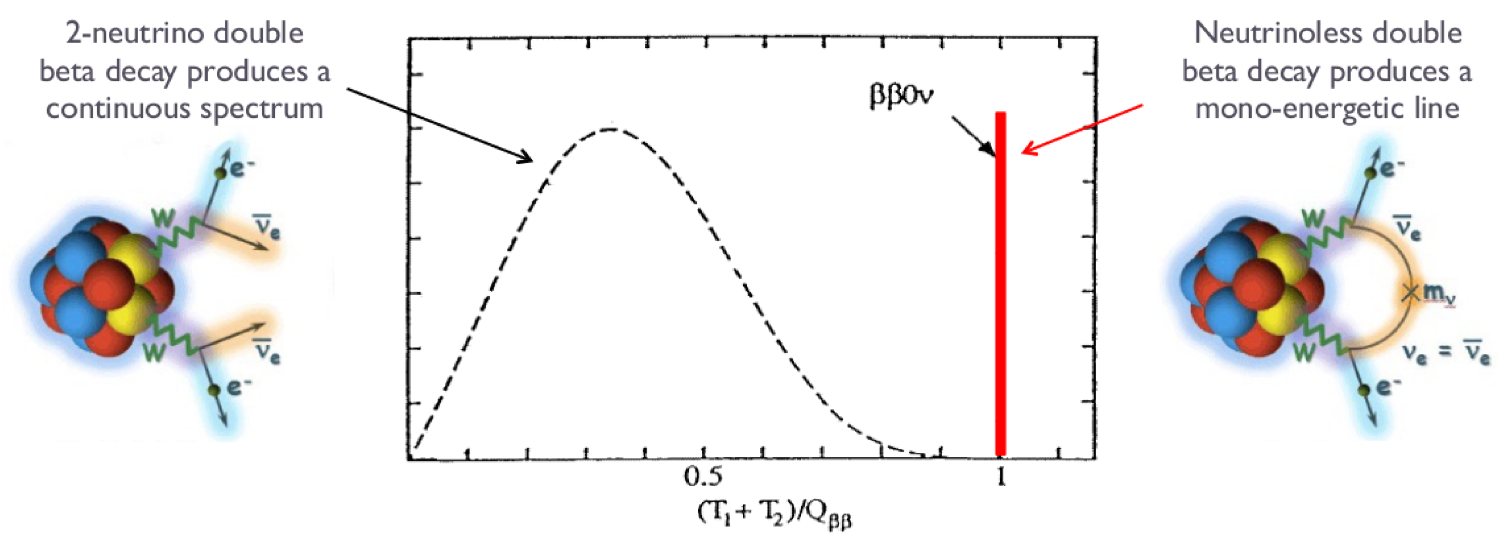
The Majorana Demonstrator at LBNL

J. Myslik for the Majorana Collaboration

Physics and Design Goals

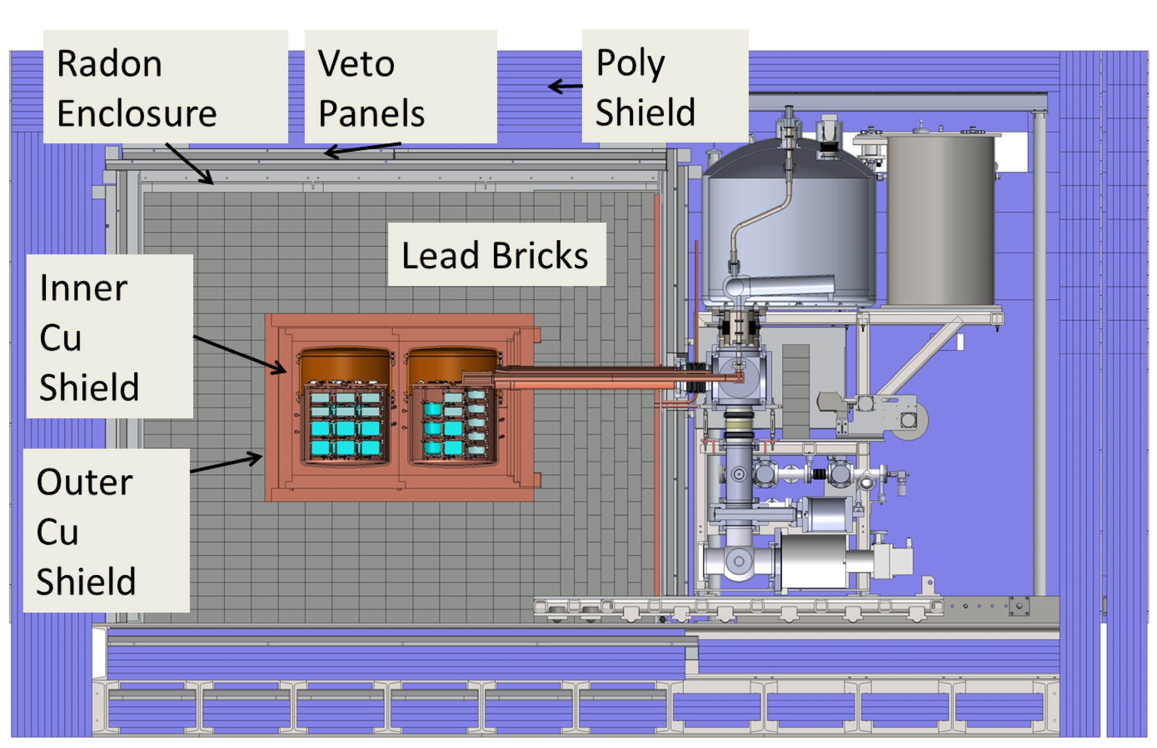
- The main physics purpose is the search for lepton number violation via neutrinoless double beta decay:



- Having good energy resolution for the outgoing electrons is important.
  - High-purity germanium detectors have excellent energy resolution.
  - ^{76}Ge can be incorporated right into the detector active volume.
- The Majorana Demonstrator has 3 design goals:
  - Demonstrate backgrounds low enough to justify building a tonne scale experiment (at or below 1 count/(ROI-tonne-year) in the 4 keV ROI around the 2039 keV Q-value of the ^{76}Ge double beta decay).
  - Establish feasibility to construct and field modular arrays of Ge detectors.
  - Search for additional physics beyond the Standard Model.

The Majorana Demonstrator

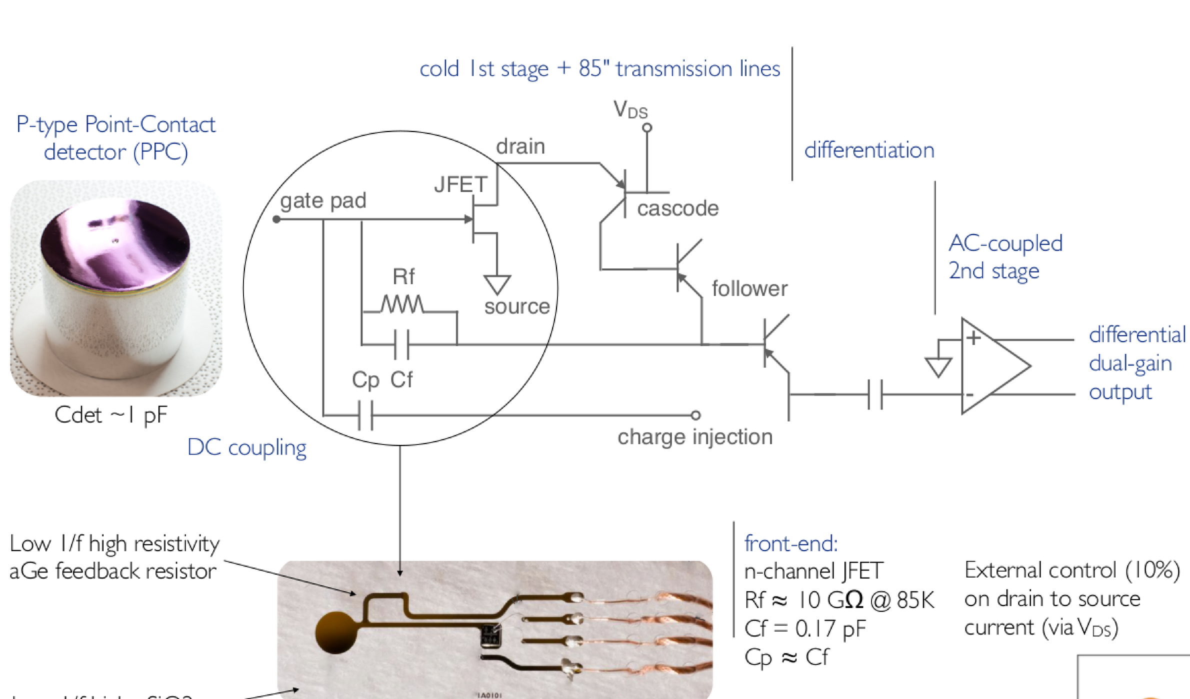
- Located at the 4850' level of the Sanford Underground Research Facility in Lead, South Dakota.

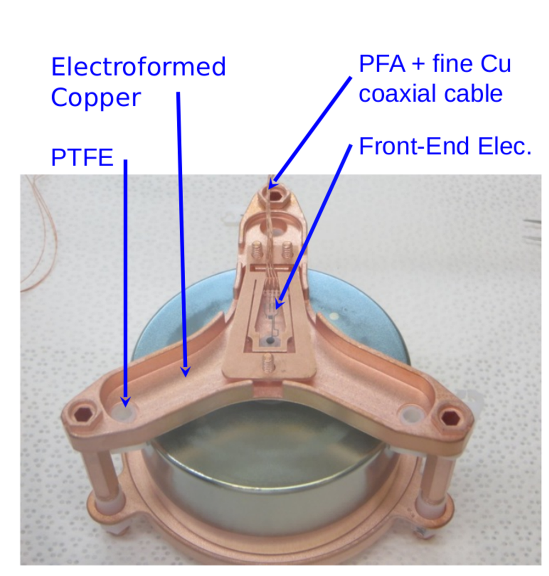


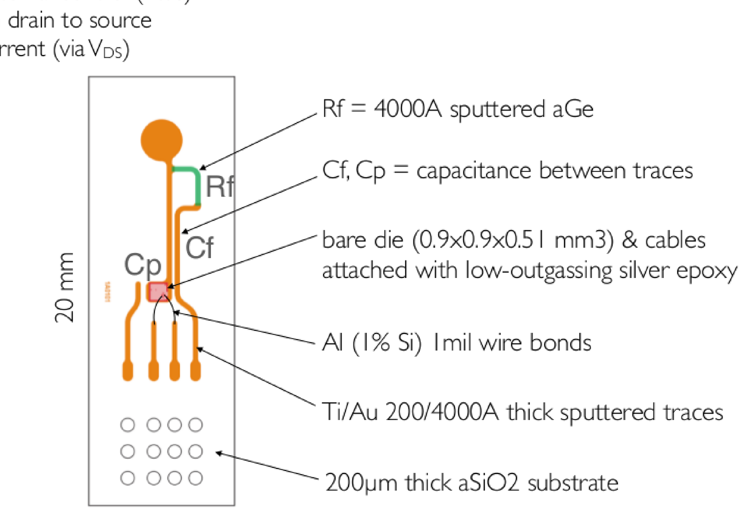
- 2 cryostat modules, each containing 7 strings of 3 to 5 p-type Point-Contact (PPC) germanium crystal detectors.
  - Longer drift time with point contact helps distinguish between single-site signal and any multi-site background interactions.
  - 29.7 kg of 88% enriched ^{76}Ge crystals, 14.4 kg natural Ge crystals (44.1 kg total).

Low-Mass Front-End Board (LMFE)

- Minimize the mass of (and therefore background due to) the detector readout.



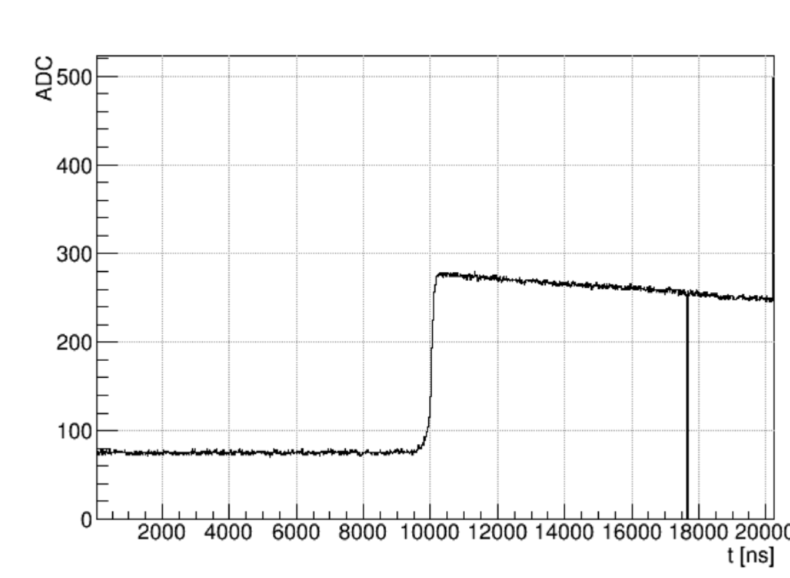




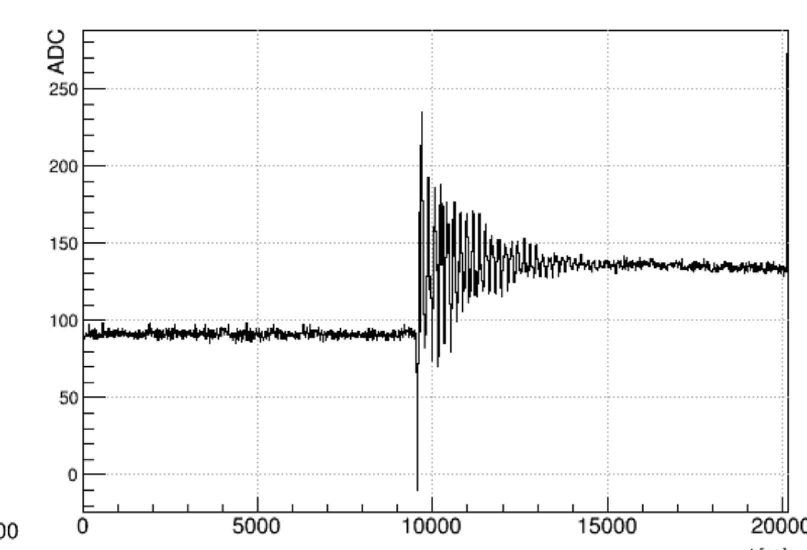
- Resistive feedback charge-sensitive preamplifier.
  - Low input capacitive load.
  - Low stray input capacitance.
  - Low 1/f components.

Removal of Instrumental Backgrounds

- Occasionally an event waveform is distorted, which will lead to problems or inaccuracies in the event reconstruction.
- The events with distorted waveforms are identified and tagged for removal within the Data Cleaning Framework.



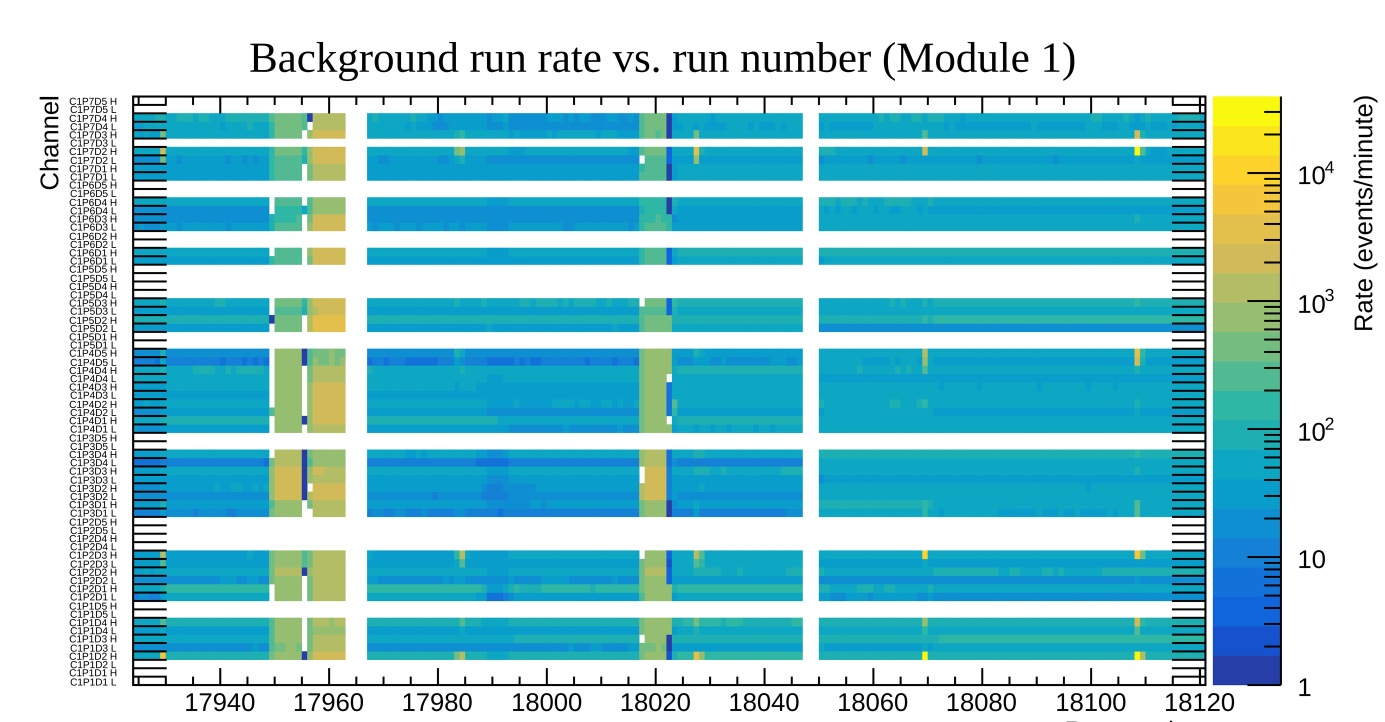
- This waveform has a flipped ADC bit, and would be identified and tagged.



- The rising edge of this waveform is obscured by some noise. Development of a tag for this population of events is currently underway.

Data Quality Assurance

- Confidence in the results of the experiment requires confidence in the quality of the data.
- A comprehensive set of checks over different timescales (e.g. individual runs, weekly, or full datasets) should be able to find signs of problems with the data produced by the detector.
- One example (below) looks at the event rate in each channel over each background run weekly.



- Background runs normally should have similar event rates in each channel. The higher rate periods here in Module 1 are the result of a radioactive calibration source in Module 2.
- Development of a modular, flexible framework for performing data quality checks is currently underway, along with the development of additional checks beyond those currently performed.

Conclusions

- The Majorana Demonstrator is a neutrinoless double beta decay experiment.
- Currently taking data at the 4850' level of the Sanford Underground Research Facility, it also serves as an important step towards a larger tonne-scale experiment.
- LBNL contributions include the delivery of the ^{76}Ge-enriched germanium detectors and signal readout electronics, and work to ensure data integrity through the development of instrumental background cuts and data quality assurance tools. With these low-level analyses in place, the group is now pursuing the search for neutrinoless double beta decays.

Acknowledgements

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